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Science News x

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CONTRIBUTIONS OF SCIENCE TO THE LIGHTING ART[1]

SCIENTIFIC work is so varied in viewpoint and objective and it is so complexly interwoven with human interpretations and technical and commonsensical applications of knowledge that it is impossible—at least in a brief paper—to establish a definite boundary between science and any of its fields of usefulness, such as a branch of engineering. Even in the scientific realm itself there is now no definite boundary between what have been termed *pure science* and *applied science*—a distinction which, in the last analysis, is now largely hypothetical. Wherever the distinction exists or is useful, perhaps the distinguishing factor is the immediate objective of the individual or of the institution which is prosecuting the work. I should define *pure science,* in the relatively rare cases where a useful purpose is served by doing so, as work done solely for the purpose of advancing knowledge. However, I have no patience with the implication of exalted purpose, as has been openly declared by some of the past members of the aristocracy of science and is still more or less delicately implied by the few remnants of that threadbare aristocracy. The old-fashioned idea of the purification of scientific work by intending and hoping and praying that it would never be put to the vulgar use of benefiting the multitude has almost completely atrophied—from lack of any use for it. Now scientific workers are rare whose viewpoint—if not their objective—is not the eventual usefulness of knowledge. Unless blinded by tradition one sees on every hand the benefits of applications of scientific knowledge. This commendable change in viewpoint and objective has also contributed toward the obliteration of the boundary line already referred to.

With gracious thanks for the knowledge inherited from pure science, the scientific worker, with increased happiness of mankind for his objective, may proudly stand alongside the so-called pure scientist. The latter follows his curiosity, overcoming obstacles or diverting his course as he wishes. The former with a definite objective before him requires not only the mental equipment of the former, but he must also be an interpreter of this knowledge into every-day usefulness and he must surmount the obstacles encoun-

[1] Abstract of an address before Section M, American Association for the Advancement of Science, Philadelphia, December 29, 1926.

tered if he is to reach the definite objective which he has chosen. And as he follows this course he does a great deal of scientific work and contributes much to the fund of knowledge. The so-called purely scientific worker increases knowledge, but it is the practical-minded interpreter who advances progress. Both are needed but, if the one is inclined to imply exalted purpose, the other may be assured that increasing human happiness, by utilizing knowledge which unused is of no value, is the most exalted purpose in human affairs.

Perhaps the foregoing may aid in demonstrating the impossibility of hewing close to the line suggested by the title of this paper and at the same time may aid in appraising the scientific contributions to the lighting art. Now let us look at the lighting art. Here again a complex web of scientific aspects confronts us. We not only have the interwoven physical sciences to consider in the production of radiant energy which is utilized in vision, but as soon as this energy produces the sensation of light we find ourselves in the extremely complex psycho-physiological realm—much of which is quite unexplored. At best in this brief paper only a few illustrative glimpses may be presented.

As in other fields of application of knowledge, we might close the discussion at this point by stating that all the accumulated knowledge since man began to think is drawn upon in some way or other in the development of the lighting art. But it would be futile to attempt to go back beyond the beginning of modern science—a few centuries ago. The possibilities of lighting increase in proportion to the safety, the convenience, the efficiency and particularly the controllability of light from adequate light-sources. Comparing the tungsten filament lamp, for example, with other light-sources in respect to the foregoing characteristics, we find that it justly deserves its overwhelming favor at the present time. A new light-source of greater luminous efficiency would also have to compete successfully with the safety and convenience of the tungsten lamp. On the other hand, no more convenient light-source has ever been produced than the candle—a portable lighting plant—but it has succumbed to greater safety, adequacy, efficiency and controllability of other light-sources. Of course, even now it has special applications where its extreme portability makes it supreme. Thus there are practical aspects which may outweigh scientific ones and *vice versa*.

In treating this subject one is confronted with great scientific principles and epochal discoveries and also with numberless details. In the first class let us begin with Newton's explanation of the spectrum of light in 1666. Who can appraise the influence of this scientific contribution? The spectral distribution of energy is the very foundation-stone of lighting. It is important in the production, the measurement and the utilization of light. Then there are the laws of radiation—of Wein, Planck, Stefan-Boltzmann and others—established during the past fifty years. These have been and are used daily in studying the spectral distribution of energy from light-sources and are intimately involved in the searching investigations of emissivity, selectivity and temperature of radiators and, consequently, of the luminous efficiency of light-sources. The electron theory likewise is found at every turn, particularly in vapor and gas conductors such as ares and so-called vacuum tubes. Metallurgical science is drawn upon heavily in the development and improvement of filament materials. But let us be content with this glimpse for the present lest we become hopelessly involved and discouraged with the magnitude of the task of giving science its due.

Let us turn to some details of gas-lighting. William Murdock about 1790 is usually credited with the first production and use of coal gas for lighting. He heated coal in closed iron containers and burned this gas in his home as it emerged from small iron pipes. However, in searching the literature we find that Clayton distilled coal in a retort at least a century before and noted that the gas emitted was inflammable. This well illustrates how unlikely the original scientific contributor of the more distant past is to receive credit, even though one were genius enough to unravel the complex web of knowledge with its threads leading into many highways and byways of science in any specific development. However, in the modern sense no outstanding achievements appear in flame light-sources until Bunsen mixed air with coal gas. The Bunsen burner revolutionized gas lighting as well as heating.

Gurney in 1826 had found that a cylinder of lime became very brilliant when heated with an oxy-hydrogen flame. Drummond immediately applied the idea to obtain powerful light-sources which he wanted in his work of surveying Ireland. The lime-light was used so widely for fifty years—particularly on the stage—that language has been enriched with the phrase, "in the limelight." Much scientific work was done along this line which eventually led to the development of the gas-mantle. Talbot in 1835 found that finely powdered lime became brilliant in the flame of a spirit lamp. He also soaked blotting paper in a solution of lime salt and incinerated it. The ash glowed brilliantly when heated. Gillard in 1848 made a mantle of fine platinum gauze which lasted only a few days. The idea was revived from time to time and it received quite an impetus after the Bunsen burner was applied to gas lighting. Welsbach was

conducting spectroscopic researches on rare earths in Bunsen's laboratory. After soaking cotton in solutions of these metallic salts and burning it, he found a replica of the original fibers remained, consisting of the oxide of the metal. This ash glowed brilliantly in a Bunsen flame. He then evolved the idea of using cotton fabric and patented the commercial mantle in 1885. This was timely for gas-lighting, because it prolonged its period of formidable competition with electric lighting for about twenty-five years.

Practicable electric light sources had already appeared—the carbon arc in 1877 and the carbon-filament lamp in 1879. They would have appeared much sooner but they had to await the arrival of practicable sources of electrical energy. Going back we find Davy the first formidable investigator of the carbon arc. He also heated wires to incandescence by passing an electric current through them. But his investigations would not have been made if Volta had not supplied the Volta pile—a source of electric energy. In 1801 Davy noted that the carbon terminals of a voltaic cell produced an electric arc when touched together and separated. In 1808 the Royal Institution supplied him with a voltaic battery of 2,000 cells—the first notable subsidization of scientific research. He exhibited and studied the electric arc on a large scale. Faraday, his assistant and pupil, was then developing a scientific foundation which in his later studies of induction was to lay the cornerstone of the great electrical development of the future.

Thus the germ of the enormous electrical industry came into being, but the actual birth of this industry must be credited to electric lighting. Forty-four years ago Edison sent all the electric filament lamps in existence in this country to the famous Pearl Street Station in New York in a market basket. In 1925 nearly a half billion electric filament lamps were manufactured in the United States. In that year in this country the total investment in electric light and power companies was nearly eight billion dollars; sixty billion kilowatt-hours of electrical energy were generated and sold for one and one half billion dollars. Of this gross revenue two thirds came from electric lighting. Add to this the investment in the manufacture of electrical apparatus and supplies and in electrical equipment and wiring and we see business, the tax-assessor, the individual and others deeply indebted to science through electric lighting.

There were many workers on electric light sources before they actually came into use and, of course, this knowledge was available to those whose names are commonly coupled with the first really practicable ones. Brush, with the arc lamp, and Edison, with the carbon filament lamp, are the most familiar in this country. Edison discovered that a current passed between the terminals of the filament through the near-vacuum. This is an example of the by-product of fundamental knowledge contributed by the inventor. This "Edison effect" has found many applications, for example, in the radio-tube.

Chemistry, spectroscopy and other branches of physical science contributed much to the development of a number of arcs. Jandus and also Marks enclosed the arc, greatly reducing the rate of consumption of carbon. At the present time, the arc has been largely relegated to special uses, although the magnetite arc, particularly, is still used to some extent in street lighting.

The carbon-filament lamp was steadily improved, but the first radical improvement was made by Whitney in 1906. The filament was treated by heating in an atmosphere of hydrocarbons, and it was so altered that it could be operated at a higher temperature with a satisfactory life. Higher temperature, in the case of filament lamps, means greater luminous efficiency. Therefore, refractoriness—high melting point—is desired. Inasmuch as carbon has a higher melting point than any of the metals now in use for filaments, one may look to it as still a possibility. The evaporation of carbon has been a limiting feature and Whitney's improvement achieved a reduction in this.

Since Mendeleeff in 1870 enunciated the periodic law of elements, scientists in the field of light-production have studied the gaps in the periodic table with much interest. One by one these gaps have been filled until the two remaining have little interest for them. They must turn more hopefully to metallurgy and to the chemistry of compounds and perhaps look toward the day when the secret of atomic structure may make it possible to make elements or compounds of the desired characteristics. This applies particularly to the production of light from incandescent solids.

In this hurried review we may pause for only a word of praise for the ingenuity exhibited by Nernst in devising the lamp which bore his name. More efficient than the carbon filament lamp which was in the field when it appeared, its cost and complex character militated against a general use of it. Tantalum and osmium were used for filaments; however, they were soon crowded out by tungsten, but experience with them was a valuable heritage. Scheele and Bergman discovered tungsten in 1781 in scheelite. It was not used for filament material until 1906—125 years later. Then it could not be drawn into wire, so the filament was made by mixing powdered tungsten with organic matter and heating this to remove

the binding material. The increased luminous efficiency and intensity of these light-sources gave a great impetus to the lighting art. The Illuminating Engineering Society was born the same year that the tungsten lamp came into use. Improvements were rapidly made and this lamp, simple though it may appear, is at the focus of various branches of science, all of which have contributed and are still contributing to its improvement.

In 1910 the development of ductile tungsten increased the possibilities of lighting enormously. There is no better illustration of the complexity of the avenues of knowledge which were traveled in this development by Coolidge and Langmuir in the Research Laboratories of the General Electric Company. Specialized knowledge of physics, chemistry, metallurgy, crystallography and the like was focused upon the problem. The result demonstrates the value of organized industrial research with definite objectives, and the necessity for great resources of all kinds for prosecuting such an investigation. Ductile tungsten made it possible to provide light-sources of all shapes and sizes necessary. For the first time glass-enclosed light-sources of high luminous intensity and small volume were available. Now the laws of geometrical optics could be more fully utilized in the design of lighting equipment. The divisibility of the tungsten filament throughout a large range adds to the prestige of this method of light-production. Lamps varying from a fraction of a watt to 30,000 watts have been made, and there is no reasonable upper limit. The age of controllable light had arrived.

In 1914 Langmuir, by a study of the dependence of heat-losses upon the size and shape of the filaments and of the physics of conduction from a solid to a gas, established the foundation for the gas-filled lamp. Now inert gases were necessary, and we must thank science for having discovered them long before. However, much scientific work was still necessary to obtain them in required quantities and in a sufficiently pure state.

Lockyer in 1868 had found new spectral lines in the solar chromosphere, which were later identified as belonging to a new element. It was named helium. This gas was isolated by Ramsay shortly after the discovery of argon in 1894. For a century preceding, it had been supposed that the composition of the atmosphere was thoroughly known. With the exception of variable quantities of moisture and traces of carbonic acid, hydrogen and ammonia, the only constituents recognized were nitrogen and oxygen. Analysis of air consisted of determining the amount of oxygen and assuming the remainder to be nitrogen. A long series of scientific observations in the interest of Prout's law had been conducted to determine accurately the densities of hydrogen, oxygen and nitrogen. The density of nitrogen was found to differ when the gas was prepared from air than when obtained from another source. This led to the discovery of argon in the atmosphere by Lord Rayleigh and Sir William Ramsay. Thus pure science supplied what is now the best vacuum substitute in tungsten filament lamps.

With these outstanding points at which science has touched our light-sources, let us pass on to the measurement and utilization of light. We now deal with light as a sensation and with vision; hence, we enter the psycho-physiological realm. We have behind us the great storehouse of scientific knowledge inherited from Helmholtz and his colleagues and those who followed. However, a large amount of scientific work remains to be done along these lines from the new viewpoint of the lighting art. The measurement of light in all its aspects is by no means a settled problem. Only a few laboratories in this country are equipped with the knowledge and experience necessary, and perhaps only two are strictly up-to-date. Even these find many gaps still existing in the knowledge available. Color-photometry is by no means completely solved and standardized. At best it is a laborious process. Spectrophotometric equipment is rare and here again accuracy depends upon experience and knowledge and attention to many details. The variation of individuals makes it necessary to use many observers, which is laborious and costly, and means are sought to standardize an observer in terms of the average of a sufficiently large and representative group. The prosecution of work in the physical sciences where unvariable instruments are used requires only one or two observers, but work in the psycho-physiological realm is valueless unless a sufficient number of observers is used to establish an average result applicable to human beings as a whole. Investigators failing to do this are guilty of a lack of appreciation of the variations of individuals from the normal. Still many researches have been published based upon the observations of only one or two observers—and unfortunately the engineer accepts them in his lack of acquaintance with the many pitfalls.

In the fields of production of light and design of lighting equipment the engineer is on safe ground because these involve the physical sciences. But the utilization of light finally involves the psycho-physiological aspects of vision and other sensations. The engineer inherited the lighting field, and although many others have entered it, the engineer still dominates it. The lighting art being so new is passing through the stage of evolution of the lighting specialist who, in order to be properly equipped, must not

only possess a knowledge of applied physical sciences, economics and the like; eventually, if he is to make his work worthy of his opportunity, he must become familiar with the psycho-physiological aspects. For the artistic phase of lighting the lighting artist is evolving, but the lighting specialist should also develop himself in this direction.

Very little work is being done on the psycho-physiological aspects of the lighting art. Only a few individuals are interested as yet. Therefore, it may be permissible to refer to the Lighting Research Laboratory at Nela Park, where systematic work is being done on the relations of intensity of illumination, speed of vision, size of test-object and contrast of test-object. This is a work of years which has grown out of continuous work in the psycho-physiological realm begun seventeen years ago. Our goal is to establish eventually a complete relationship of these and other factors. Glare and visibility are also being studied year after year with the hope of eventually showing how improper lighting distorts the relationships already mentioned. Besides these we are studying such factors as eye-fatigue, visual acuity, accuracy, effect of contrast, color-vision and certain psychological effects of light and color as they influence the efficiency, the production, the welfare and the happiness of individuals. The large number of observers and the time required make such work laborious, but the results are supplying the foundation of knowledge for the development of lighting. Much more scientific work is needed relating light, lighting, color and vision. A few individuals are working elsewhere, but science has not generally awakened to the great importance and opportunities of work in the psycho-physiological realm of light and vision.

Illuminating engineers and others have applied scientific methods and knowledge to such developments as the coefficient of utilization method in the design of lighting installations, the visibility of electric signs, the design of lighting equipment utilizing the laws of geometrical optics and to the development of artificial daylight, colored accessories, special lamps and portable photometers.

Scientific methods are being employed in actual tests of street lighting, of automobile headlamps, of production in factories as influenced by lighting, of the relation of safety and lighting and other phases of lighting, but they are handicapped by the scanty knowledge and doubtful test-methods as yet available. The special applications of lighting in which scientific knowledge and research is entering already are vast in number.

I have dwelled longer upon light-production than upon light-utilization. But this has been done because the former has been well developed, and scientific work in the latter field only began relatively recently. The science of light-utilization, so far as it touches vision and the user of light, is in the early stages of evolution. It is getting its bearings; it is designing and trying out its tools—test-methods; but it is already involved in many fascinating problems, only a few of which have been mentioned in the foregoing. With space limited and with the work barely begun, it seems best to give only this glimpse to show what the field is like. However, I wish to emphasize that lighting, upon which vision is dependent, is important enough to demand not only the attention of the engineer and of every employer and user of light, but the assistance of many qualified scientific investigators in the psycho-physiological realm. The few of us associated with the work in this field find it difficult to avoid being overwhelmed with a view of the work to be done. The lighting specialist is waiting for more foundation upon which to build the utilization of light. There is nothing spectacular to attract workers to the field. On the contrary, the work is complex, tedious and time-consuming. However, there is the fascination of entering a field which explorers have just invaded and the satisfaction that one is dealing with an essential to our most important sense—vision. Furthermore, artificial lighting is still so far from the ideal in intensity and quality of the daylight under which our eyes evolved, that we may look forward into the misty future before seeing artificial light overtake natural light in these respects. And then, finally, we may have the satisfaction of improving upon natural light and lighting. Who knows? No one, for scientific investigation has still to supply the answer.

M. LUCKIESH

NELA PARK,
CLEVELAND, OHIO

BARRO COLORADO ISLAND BIOLOGICAL STATION

THE National Research Council has received the third annual report of the executive committee of the Institute for Research in Tropical America, prepared by Dr. Thomas Barbour, acting chairman of the committee. It is, in effect, a report on the conditions and activities of the Barro Colorado Island Biological Station for the period March 1, 1926 to February 28, 1927.

The station was closed to visiting scientists for a part of this year owing to the fact that extensive repairs were necessary to the launch, and that a great deal of new construction was undertaken which made it necessary to use the living accommodations for workmen. It was possible, however, to arrange

the plans of scientists who wished to visit the island so that their needs were met and no serious difficulty resulted from this arrangement, which will probably not have to be repeated.

Grateful acknowledgments are made to the governor of the Panama Canal, Colonel M. L. Walker, and to Colonel Harry Burgess, for their continued whole-hearted cooperation; also to Mr. Sam H. Heald, superintendent of the Panama Railroad, and to chief of police and the chief hydrographer, as well as to officers of the United Fruit Company, for many favors. The War Department, the governor of the canal, the United Fruit Company, and the Panama Railroad Steamship Company continue to make important concessions regarding the transportation of scientific workers from New York to and in and from the Canal Zone.

Dr. Frank M. Chapman, of the American Museum of Natural History, contributed $500 for a small new building suitable for living quarters and private laboratory which is available to other workers when Dr. Chapman is not using it. A substantial screened outdoor cage, 9 feet square by 7 feet high, suitable for sloths, monkeys, or other animals has been built back of the main laboratory. Five commercial firms have joined in building a new house, 16 feet by 16 feet, using lumber that had been treated to enable it to repel attacks of termites. Another building, 18 feet by 18 feet, has been built of redwood donated by the Little River Redwood Company of California, as an experiment to test the resistance of untreated redwood to termites. The Redwood Export Company of California has also contributed 15,000 board feet of redwood lumber and shingles with which to build other test buildings.

The clearing around the laboratory buildings has been considerably enlarged, trails have been extended and marked, and a channel wide enough for the station's large launch has been cut through the submerged forest all around the island, which makes it much easier for workers to explore the island shores, as well as easier to patrol the island against poachers. It is proposed to cut side channels from the main channel to each of the trails that open on the lake. The total length of the present trails is nine miles. They enable one to reach almost all parts of the island. The total coast line of the island exceeds 25 miles. The area of the island is 5.64 square miles.

The number of scientific workers and visitors on the island has been less perhaps than last year partly due to the closing of the station for a part of the year in order to make necessary repairs, but applications for places in the station for the coming summer are already numerous. The reports of workers who have visited the station in past years concerning the conditions for work and the ease with which the station may be reached are so uniformly favorable that the station is going to have difficulty in providing accommodations for the many who wish to come. However, the station officers will do whatever they can to take care of all applicants. Information regarding conditions of visiting and working at the station, and means of transportation, may be obtained from Dr. Thomas Barbour, Museum of Comparative Zoology, Cambridge, Massachusetts. On arrival at the station the visitor should learn details concerning the station's facilities for living accommodations and for work from Mr. James Zetek, resident custodian of the station. To consult with him in advance of arrival he should be addressed at Box 245, Ancon, C. Z.

The Barro Colorado Island Station is a success, but it needs help for extension and betterment. Universities and scientific organizations may help the station and at the same time help their own faculty members and advanced students interested in tropical biological research by subscribing for "tables" at an annual cost of three hundred dollars. This annual support will be of much use to the station, but a permanent endowment of from $100,000 to $200,000 is sorely needed. At present, the continued existence of the station is only maintained through the personal generosity of Dr. Barbour, Dr. David Fairchild and a few others. This is unfair and can not go on forever.

VERNON KELLOGG,
Permanent Secretary
NATIONAL RESEARCH COUNCIL

REPORT OF THE PRESIDENT OF THE ECOLOGICAL SOCIETY OF AMERICA ON THE QUESTIONNAIRE OF 1926

THE questionnaire sent out by your president with reference to research to the 602 members of the Ecological Society of America resulted in the receipt of slips from eighty-six members, or one seventh of the total membership. Twenty-six botanists, seven foresters and fifty-three zoologists returned the blanks filled out with many interesting details of their work and their hopes for future research. Space and time will not allow a complete analysis of the returns. The blanks will be kept by your president and will be accessible to members who may be interested in them.

The question, "Does your institution encourage research?" was answered by seventy-nine members. Fifty-eight persons unequivocally replied that the institution with which they were connected encouraged research. Six answered in the negative, one

that research was not directly encouraged; another member replied that his institution wished it, but that the work was too heavy to allow it, and another individual answered that his institution theoretically did.

The replies as to the amount of time which could be devoted to research were most varied. Nineteen, the largest number under any category, replied that they had little time for research except vacation. Ten replied that they could devote one fourth or one third of their time to original investigations. Ten said they could give full time to research, as the terms of their employment called for research. Eight answered that they could devote one half of their time to research. Three reported that they had one tenth of their time free and three that they used evenings and Sundays for research work and three that they could not give very much time. The above categories as to time include fifty-three members. The other categories reported by two members under each included twelve hours per week, six to eight hours weekly, vacations and one day weekly, three fourths of the academic year and all summer. The other items given below were answered by one member each: four hours per day, one day a week, eighteen hours per week, two hours per day, spare time only, 20 per cent. of time, whatever is left after routine duties, eight months on economic entomology, half time in March, April and May, full time in June, July and August and sometimes half a day, some time in vacation and sometimes two consecutive whole weeks.

As to library facilities, there were eighty-one replies out of eighty-six, the total number of returns. Forty-six reported the library facilities as good, twenty-five as poor and ten as fair. So that from the questionnaire one might glean the fact that the library facilities are fairly satisfactory.

The reply to the query No. 7, "How much money will it take to complete the piece of research on which you are engaged?" elicited the most interesting facts. The smallest sum suggested by any one person was five dollars and the largest twenty thousand ($20,000). One individual replied that $1,000,000 was needed, but he probably had in mind the needs of the institution with which he was connected and not individual requirements. I will deal here with totals. The total for twenty-six botanists was $26,900, or almost exactly $1,000 apiece. Two foresters, out of seven who replied, estimated that $14,000 would be desirable, and the fifty-three zoologists who replied, omitting the one million dollar item, asked for a total sum of $52,005, or about one thousand ($1,000) apiece. The total amount required by eighty-six ecologists was $92,905. It seems, therefore, after averaging the returns that one thousand dollars a year would be a fair amount to devote to research by the average research worker in the Ecological Society of America. As there are 602 members in the society, that would mean a yearly outlay of $600,000 for ecological research alone. If we capitalize that amount of money at 5 per cent. interest, it aggregates $12,000,000; in other words, if the Ecological Society of America were to grant $1,000 per year to each of its members for ecological research, it would mean the accumulation of an endowment fund of $12,000,000. Of course, the reply to this estimate would be that every member of our society would not require $1,000 a year for research, for contingencies arise which would prevent such active work on the part of each individual registered as members of the society. As ecologists should travel extensively, we might enlarge the purposes of the yearly allotment by saying that each member of the Ecological Society of America should have from $12,000,000 invested funds $1,000 for research and travel.

Finally, the character of the projects and research work vary as greatly as the number of individuals who returned the blanks. A few will be given to show the scope of the work undertaken by members of the Ecological Society of America. Some of the zoological items are as follows: Geography of regions north of 60°; mammal communities; life zones; habitats and associations of animals in Turkestan; life histories of snakes and salamanders; distribution and food habits of Ohio fishes; bird distribution with relation to life zones and faunal areas; biology of South American fishes; physiology and ecology of lamellibranch molluscs, especially oysters and teredo; systematic and distributional study of the water mites (Hydrocarina); oligochetes effect on crop plants; mites, or acarina called Orbatidae, living in moss and decaying vegetation or on living plants; hibernation and other aspects of biology of codling moth; cereal crop insects; protozoology, monograph of Ciliata; physiological aspects of animal ecology; influence of climatic conditions, especially upon man. Some of the problems which interest the botanists are: propagation of native plants of America; symbiosis, especially ectotropic mycorhizas; plant physiology; also ecological anatomy; hybridism and epharmonic response in the New Zealand floras; relative effects of soil acidity; ecology of alkali plants; influence of environment on diseases of beans; successional studies and problems in plant distribution; sphagnum bogs; plant ecology of the mountains of western North Carolina; grazing with successional studies and general ecological problems; growth and natural succession of aspen and paper birch in northern Minnesota, Wisconsin and Michigan in relation to environmental factors; relationship between weather and forest fire

danger; effect of forests on climate; streamflow and erosion. All of which is respectfully submitted.

JOHN W. HARSHBERGER,
President for 1926.

RESOLUTION BASED ON RETURNS OF THE QUESTIONNAIRE

Resolved by the Ecological Society of America in session at Philadelphia, Tuesday, December 28, 1926, that through its individual members the following minute be submitted to the boards of control of the institutions represented by its membership; the society advocates that men or women engaged in active research work be allowed to devote one fourth or one half time to such investigation, and where they can show that money is needed for such investigation, that $1,000 be allotted to them in the budget of that institution for research and travel and that the library and research facilities of the institution be made commensurate with the original investigations presented therein.

SCIENTIFIC EVENTS

THE RUSSIAN ACADEMY OF SCIENCE

THE Soviet Union Information Bureau sends the following account of the annual public meeting of the Academy of Science in the U. S. S. R., which took place in Leningrad on February 2. The opening speech was made by A. P. Karpinsky, the president of the academy. The permanent secretary, S. F. Oldenburg, made the report for 1926. The meeting was attended by numerous representatives from scientific institutes in Leningrad and other parts of the Soviet Union.

Dr. Oldenburg in his review of the activity of the academy during the past year pointed out that the basic task consisted in the attempt to intensify systematized work in scientific institutes, which was especially necessary in order to bring about the successful industrialization of the country. Work along these lines is being carried on not only within the Soviet Union, but also on an international scale. To this end, scientific conferences are being held throughout the Soviet Union. Further, fifteen academicians went abroad during the past year; six associate members and twenty-one scientific assistants. The academicians during their investigations abroad negotiated for mutual exchange of scientific specialists who should deliver lectures on their specialties and also for the dispatch of young scientists to work in scientific institutes. The question of systematic exchange of scientific reference literature was also raised and is being carried on very successfully in France; already a considerable exchange of books has taken place. The academicians were particularly impressed by the interest displayed abroad in Russian scientific activities.

Despite the fact that during the past year much time has been devoted to organization work, more than three hundred articles and books have been published and over four hundred lectures delivered by the academicians in various institutes and societies.

The library of the academy, which has been transferred to new premises, added during the past year 141,389 volumes to its collection and circulated 150,000 books.

The scientific institutes of the academy are divided into the following groups: four scientific institutes, two independent laboratories, seven museums and auxiliary institutes; fifteen permanent scientific commissions and in addition one biological station and one institute outside Leningrad.

In addition to these institutes here mentioned a number of commissions also function. During the past year a new commission was formed: the research committee for the investigation of Soviet and Autonomous Republics; there is a commission for research into Yakut U. S. S. R. under the control of this commission. The expeditions undertaken during the past year, which covered a considerable portion of the territory in the Soviet Union, were most successful.

The academy was especially active in publishing work during the year under review, when 132 books were published, whereas in 1925 99 books were published. As regards circulation of academic publications, 89,333 were sold in 1926 as compared with 52,000 in 1913.

OPENING OF THE UWEKAHUNA OBSERVATORY

DURING the visit to Kilauea of the Pan-Pacific Conference on Education and Recreation recently held in Honolulu, Dr. Hubert Work, U. S. Secretary of the Interior, on April 19 opened to the public the new Uwekahuna Observatory and Exhibition Room of the Hawaiian Volcano Research Association.

Dr. Jaggar made a short address, mentioning the fact that for 11 years past it has been the hope of the workers at the Hawaiian Volcano Observatory that some sort of a trailside museum might be provided for which would make it possible to explain to travelers in an appropriate setting the fascinating mechanism of volcanoes, and at the same time show them pictures of recent activities and maps or diagrams illustrating the relation of the Hawaiian volcanoes to the surface features of the globe. Thanks to the liberality of congress in creating the volcanology section of the Geological Survey in 1926, the

research association supplied money for the building of a small exhibit hall equipped with electric current and projection apparatus. This is now finished, and some of the best of the collections of the observatory have been placed in display cases, the whole room being faced with large plate-glass windows that command a magnificent view southward of the whole Kau Desert and Halemaumau pit. As the buildings and equipment furnished by the Hawaiian Volcano Research Association are all part of the plant of the observatory, Dr. Jaggar took occasion to convey the new establishment to the use of the Department of the Interior through the two branches here presented, the National Park Service and the Geological Survey.

Secretary Work accepted the offering on behalf of the Department of the Interior, and short speeches were made also by Honorable Stephen T. Mather, director of the National Park Service, and by Honorable Wallace R. Farrington, governor of Hawaii.

The new buildings are of iron, with rough stone corner posts, the smaller one housing the water tank, preparation room and power plant, the larger one standing on the highest rim of Kilauea Crater, with a terrace in front designed to display the view that on bright mornings extends all the way from Mauna Kea and Mauna Loa around past the south point of the island in panorama, and thence eastward, including all the cones and landmarks of the Kau Desert, to Halemaumau, spread out at the feet of the observer as an enormous chasm less than a mile away. Beyond it and around is seen all the detail of Kilauea Crater and the pits Keanakakoi and Kilauea Iki, while in the distance to the east lies Puu Huluhulu, that marks the site of the new Chain of Craters Road, which Secretary Work dedicated the same morning.

It is hoped eventually to install on the terrace a large Zeiss binocular telescope, and projection apparatus for lantern slides and motion pictures has already arrived, and in a short time will be installed and in operation.

T. A. J.

AWARD OF COMMONWEALTH FUND FELLOWSHIPS

COMMONWEALTH FUND fellowships amounting to $125,000 have been awarded to twenty-three honor graduates of British universities who are to come to the United States next fall for two years' study in American universities. This is the third annual group of such awards and makes a total of sixty-three young scholars so far given opportunity for education and travel in the United States under the auspices of the Commonwealth Fund. To the twenty annual fellowships provided under the original plan, three new fellowships have been added this year for honor graduates of British Colonial universities at present studying in Great Britain. The first awards in this group go to men from the University of Sidney, Australia, the University of Tasmania and Natal University College.

A list of the appointments in the sciences follows:

Harvard University: James M. Alston, from the University of Edinburgh, to study bacteriology.

Princeton University: Maurice Black, from Cambridge University, to study the geology of the Appalachian region.

Massachusetts Institute of Technology: David Graham, from Queens University, to study high tension electrical transmission.

Pennsylvania: Robert Robinson, from Birmingham University, to study electro-chemistry.

Johns Hopkins: Thomas Frederick Hewer, from the University of Bristol, to study bacteriology.

Clark: Ethel Simkins, University of Liverpool, to study agricultural geography.

Chicago: Alexander Oppenheim, Oxford, to study mathematics.

North Carolina: Leif Egeland, from Natal University College and Oxford, to study inter-racial problems.

Michigan: George F. Brett, University of Leeds, to study physics.

FIELD WORK OF THE CALIFORNIA ACADEMY OF SCIENCES

DR. BARTON WARREN EVERMANN, director of the museum of the California Academy of Sciences, announces expeditions of that institution for the season of 1927 as follows:

1. Mr. J. O. Martin, of the department of entomology, will spend the spring and summer in the Panhandle of Texas collecting insects, paying special attention to the Coleoptera and Hemiptera.

2. Mr. Harry S. Swarth, curator, and Mr. Joseph Mailliard, curator emeritus, department of ornithology and mammalogy, with Mr. Raymond M. Gilmore, of the University of California as assistant, are in southern Arizona, studying the birds and mammals of that region and making collections for the academy.

3. Mr. Joseph R. Slevin, assistant curator department of herpetology, and Mr. Frank Tose, chief taxidermist, are working in southern California along the Arizona border making a survey of the herpetological fauna of that region and making collections of reptiles and amphibians and securing materials for habitat groups for the museum.

4. Mr. George Haley, professor of biology in Saint Ignatius College, San Francisco, and Mr. G. C. Harrold, expert collector and taxidermist of Winnipeg, will devote the summer and early fall to biological investigations on Nunivak Island, a large island in the eastern part of Bering Sea, which is little known biologically. They will pay particular attention to the birds, insects, mollusks and land flora.

5. The department of paleontology and geology, under the general direction of the curator, Dr. G. Dallas Hanna, will make studies of certain of the islands off the California coast, including Catalina, Santa Cruz, Santa Rosa and San Miguel. Collections from California are being assembled from many localities of historic interest in paleontology.

6. Mr. E. P. Van Duzee, curator of the department of entomology, will spend June collecting insects in the Sierra Nevadas with headquarters at Truckee, and his assistant, Mr. H. H. Keifer, will do some general collecting in central California.

7. Miss Alice Eastwood, curator of botany, is visiting type localities in California for the purpose of obtaining topotypes of species of plants needed in the herbarium.

SCIENTIFIC NOTES AND NEWS

DR. HENRY FAIRFIELD OSBORN, president of the American Museum of Natural History, has been elected a corresponding member of the French Academy of Sciences.

THE Bavarian Academy of Sciences has elected the following to corresponding membership: Dr. Thomas Hunt Morgan, professor of experimental zoology at Columbia University; Dr. Arthur Stanley Eddington, professor of astronomy and director of the observatory at the University of Cambridge; Dr. Godfrey Harold Hardy, professor of geometry at Oxford University, and Dr. Wladimir Beneschewitz, professor at the Leningrad Academy.

ON May 21, the Helminthological Society of Washington gave a dinner in honor of Dr. Charles Wardell Stiles, chief of the division of zoology in the Hygienic Laboratory of the U. S. Public Health Service, as a celebration of his sixtieth birthday. Among the invited guests who greeted Dr. Stiles and spoke of his contributions to parasitology were the following: Dr. Adolpho Lutz, of the Instituto Oswaldo Cruz, Brazil; Dr. L. O. Howard, chief of the Bureau of Entomology, and Dr. Leonhard Stejneger, head curator of biology of the U. S. National Museum. Addresses were also made by the following members of the Helminthological Society of Washington: Dr. Paul Bartsch, curator of the division of mollusks of the U. S. National Museum; Dr. W. W. Cort, professor of helminthology in the School of Hygiene and Public Health of Johns Hopkins University; Dr. M. C. Hall, chief of the zoological division of the Bureau of Animal Industry, and Dr. N. A. Cobb, senior nematologist of the Bureau of Plant Industry. Dr. Benjamin Schwartz, president of the Helminthological Society of Washington, presided.

DR. W. D. COOLIDGE, assistant director of the research laboratory of the General Electric Company, has been awarded the medal of the American College of Radiology, "in recognition of his contribution to radiology and the science of medicine."

ORVILLE WRIGHT has been notified that the Washington award for the most noteworthy achievement in engineering development has been awarded to him. The award is granted jointly by the National Societies of Civil, Mining, Mechanical and Electrical Engineers and the Western Society of Engineers. The ceremony took place in Chicago on June 1.

THE honorary degree of doctor of laws was conferred by Wesleyan University on May 26 upon Dr. George D. Olds, president of Amherst College, formerly professor of mathematics.

SAMUEL E. DOANE, chief engineer of the National Lamp Works, received an honorary degree in electrical engineering at the graduation exercises of the Case School of Applied Science.

DR. GEORGE CLARIDGE DRUCE, Fielding curator of botany in the University of Oxford, has been recommended for election into the Royal Society, to fill the vacancy in the list of new fellows created by the death of Professor A. A. Lawson, of the University of Sidney.

THE Rockefeller Foundation has elected to its board of trustees Herbert S. Hadley, chancellor of Washington University, St. Louis; Dr. David L. Edsall, dean of the Medical School of Harvard University, and Dr. George H. Whipple, dean of the school of medicine and dentistry, University of Rochester.

DR. LEIGH PAGE, professor of mathematical physics at Yale University, has been elected president of the Yale chapter of the Sigma Xi, succeeding Professor Philip G. Laurson, who retires.

AT the meeting of the American College of Physicians in Cleveland in February, Dr. A. S. Warthin, professor of pathology in the medical school, University of Michigan, was reelected first vice-president and editor of the *Annals of Clinical Medicine*.

W. G. CAMPBELL, director of regulatory work of the U. S. Department of Agriculture, will administer the work under the food, drug and insecticide administration, which takes form on July 1. Dr. P. B. Dunbar, now assistant chief of the Bureau of Chemistry, will be assistant chief of the new administrative unit.

F. STANLEY HOWE, assistant business manager of the Rockefeller Institute for Medical Research since 1920, has resigned to become director of the Orange Memorial Hospital, New Jersey.

PROFESSOR JULIAN S. HUXLEY is resigning the chair

of zoology in King's College, London, to which he was appointed two years ago. Dr. Huxley will continue to be attached to King's College in an honorary capacity, but intends to devote himself entirely to writing and research.

DR. RAYMOND PEARL, professor of biology in the Johns Hopkins Medical School and director of the Institute of Biological Research, left for London on May 25 to deliver a series of lectures at University College, London. Dr. Pearl also will give addresses at Geneva on the biology of population growth in connection with the World Population Conference, and in Berlin at the International Genetics Conference on the subject of eugenics.

DR. WILLIAM S. SEIFRIZ, professor of botany; Dr. William S. Pardoe, professor of hydraulic engineering, and Dr. Isidore S. Ravdin, assistant professor of research surgery, all of the University of Pennsylvania, have received leaves of absence to study abroad during the next academic year.

DR. WILLIAM LLOYD AYCOCK, associate in preventive medicine and hygiene at the Harvard Medical School, has gone to England to study an outbreak of infantile paralysis in the schools of Kent, England.

PROFESSOR EDWARD W. BERRY, of the Johns Hopkins University, will spend the summer in geological explorations in southern Ecuador and northern Peru.

H. W. KRIEGER, ethnologist of the Smithsonian Institution, has left for the Lower Yukon to investigate the remains of an extinct Indian race. The expedition was made possible by a grant from the Joseph Henry fund of the National Academy of Science.

NEIL M. JUDD, curator of American archeology, United States National Museum, left Washington on May 28 for the purpose of completing his explorations for the National Geographic Society at Pueblo Bonito, New Mexico. The current expedition is the seventh sent by the society for the purpose of recovering and recording the story of this prehistoric Indian village. Mr. Judd's staff this summer has been reduced to five; the party will be concerned wholly in the preparation of the scientific reports covering the six previous expeditions.

PROFESSOR JOHN J. ABEL, of the Johns Hopkins University, gave the Willard Gibbs address under the auspices of the Chicago section of the American Chemical Society, on May 27. The presentation of the Willard Gibbs Medal to Dr. Abel was made by Dr. Julius Stieglitz, chairman of the department of chemistry at the University of Chicago.

DR. SIMON FLEXNER, director of the Rockefeller Institute for Medical Research, will deliver the address at the special convocation to be held at Brown University on June 14, for the conferring of advanced degrees.

DR. FRANK BILLINGS, emeritus professor of medicine at the University of Chicago, will be convocation orator at the university on June 14. His subject will be medicine and human progress.

PROFESSOR DAYTON C. MILLER, of the department of physics in the Case School of Applied Science, gave a lecture entitled "The Basis of Tone Quality in Instrumental Music," at the Engineering Societies' Building, New York City, under the auspices of the Museums of the Peaceful Arts, on May 24.

DR. MICHAEL I. PUPIN, professor of electromechanics at Columbia University, recently gave a free public lecture at the University of Chicago under the auspices of the Hiram W. Thomas fund. His subject was "Coordination—The Message of Science."

DR. W. J. HUMPHREYS gave an illustrated lecture on "Some Facts and Fancies of Weather Lore" to the society of the Sigma Xi at the Johns Hopkins University on May 19.

DR. F. K. RICHTMYER, of Cornell University, gave an address on May 19 before the Sigma Xi alumni association of the University of Pittsburgh on "The History and Present Status of the Radiation Problem." At the dinner preceding the address, Professor Richtmyer described the early history of the Sigma Xi and spoke of its idealistic aims and purposes.

SIR GEORGE NEWMAN, chief medical officer of the British Ministry of Health, gave the first of the four Dodge lectures at Yale University on May 23. Sir George has chosen as the general subject of his lectures, "Citizenship and the Survival of Civilization," which he gave on the three succeeding days.

THE Schorstein memorial lecture was delivered by Professor Knud Faber in the anatomical theater of the London Hospital Medical College on May 19 on "Gastritis, its Relation to Achylia and Ulcer."

A STATUE of the Comte de Chardonnet, the French chemist who invented one of the first processes for the manufacture of artificial silk, is to be erected by the Academy of Science and Art at Besançon.

GEORGE BISHOP SUDWORTH, chief dendrologist of the U. S. Forest Service, authority on the trees of the United States, died on May 10 at the age of sixty-three years.

THE ninth annual meeting of the American Society of Mammalogists was held at the Academy of Natural Sciences of Philadelphia from April 27 to 30, with

60 members in attendance. Thirty-six items, including motion pictures and papers covering a wide variety of topics, were presented during the seven sessions of the first three days. The annual dinner was held on the evening of April 28. At the business meeting officers for the ensuing year were elected as follows: *President,* Glover M. Allen, Museum of Comparative Zoology; *vice-presidents,* Witmer Stone, Academy of Natural Sciences, and T. S. Palmer, U. S. Biological Survey; *recording secretary,* H. H. Lane, University of Kansas; *corresponding secretary,* A. Brazier Howell, U. S. National Museum; *treasurer,* A. J. Poole, U. S. National Museum, and *editor,* H. H. T. Jackson, U. S. Biological Survey. The meeting was concluded by a tour of the zoological park on Saturday, and luncheon as the guests of the Philadelphia Zoological Society.

THE Cooper Ornithological Club held its second annual meeting in San Francisco and Berkeley April 29 and 30. The first day's sessions were held in the auditorium of the California Academy of Sciences in Golden Gate Park. Noon luncheon was provided by members of the academy and a complimentary dinner to club members and their guests was given by the academy at the Clift Hotel, San Francisco, at which about 90 were present.

THE twenty-sixth annual meeting of the North Carolina Academy of Science was held at Davidson College, Davidson, N. C., on May 6 and 7, 1927. Thirty-eight new members were elected, giving a total of two hundred and sixty-four members in the North Carolina Academy of Science. The twenty-seventh annual meeting will be held at the University of North Carolina, Chapel Hill, N. C., in the spring of 1928. The officers elected for the year 1927–28 were as follows: *President,* J. M. Bell; *vice-president,* W. L. Porter; *secretary-treasurer,* H. R. Totten; *executive committee,* the officers, and H. B. Arbuckle, J. W. Nowell, and A. H. Patterson; *representative* to the A. A. A. S. council, Bert Cunningham.

THE eighth annual meeting of the New Hampshire Academy of Science will be held at Waterville, from Friday to Sunday, June 3 to 5. The headquarters for the meeting will be the Waterville Inn. Mr. J. H. Foster, state forester, will lead a field trip on Sunday.

THE twelfth annual meeting of the Optical Society of America will be held at Schenectady, N. Y., on Thursday, Friday and Saturday, October 20, 21 and 22, 1927.

THE one hundred and forty-fifth regular meeting of the American Physical Society was held in Washington, on April 22 and 23, in the new building of the National Academy of Sciences.

THE fifty-eighth annual meeting of the Canadian Medical Association will be held at Toronto from June 13 to 18, in conjunction with the Ontario Medical Association, the Canadian Public Health Association, the Canadian Tuberculosis Association, the Canadian Society of Anaesthetists, and the Canadian and Ontario Radiological Societies. The scientific proceedings will include general sessions and a number of sectional meetings, the sections being: Anaesthetics; eye, ear, nose and throat; medicine; obstetrics and gynaecology; pathology and bacteriology; pediatrics; public health; radiology, and surgery. The second Listerian oration will be delivered on June 17 by Sir C. S. Sherrington, Waynflete professor of physiology at Oxford. Other visitors from Great Britain who are taking part in the conference include Sir G. Lenthal Cheatle, Dr. J. Strickland Goodall, Dr. A. L. Fleming and Dr. S. Gilbert Scott, who will represent officially the British Medical Association. The sections of pathology, radiology, medicine, anaesthesia and surgery will combine for a discussion of the gall bladder; and pathological demonstrations are to be arranged with special reference to the problems of the medical practitioner.

ACCORDING to the *Journal* of the American Medical Association, a program has been arranged for the dedication from June 13 to 17 of the new buildings of Northwestern University Medical School on the McKinlock Campus, East Chicago Avenue near the lake. There will be alumni clinics in all the departments of the Montgomery Ward Memorial in the mornings. The Archibald Church Library and the Frederick Robert Zeit Museum of Pathology will be dedicated in the afternoon, June 15, and oil portraits of the founders of the medical school—Nathan Smith Davis, William H. Byford, John H. Hollister, Ralph N. Isham and Davis Rutter—will be unveiled; also busts of Edmund Andrews, Robert L. Rea and others, and oil portraits of John Harper Long and Frank Billings. The alumni dinner will be that evening at the Congress Hotel. On the afternoon of June 16, the Robert L. Rea professor of anatomy will be installed, and the James A. Patten research laboratories of bacteriology dedicated. In the evening Dr. Hugh T. Patrick will address a special convocation in the John B. Murphy memorial auditorium, and the following evening former governor Frank O. Lowden will speak at the general exercises in dedication of all the new buildings. There will also be special dedication programs for the new law and commerce schools of Northwestern, which are adjacent to the medical and dental schools on the McKinlock Campus.

THE committee on scientific research of the American Medical Association has awarded a grant of $750 to Dr. Laurence H. Snyder, associate professor of

genetics at North Carolina State College, for investigations on the relationships of the blood groups to other human hereditary characters, and the practical applications of such relationships. A grant of $500 has been made to Dr. C. W. Apfelbach, of the Presbyterian Hospital, Chicago, to aid in defraying the expenses of a study of the functional alterations in the kidneys of dogs altered by infarction of the glomeruli with carbon particles.

REGENTS of the University of Wisconsin have accepted the gift of the scientific library of the late Dr. Frederick Belding Power, first head of the course in pharmacy at the university, from his daughter, Mrs. Louise Power Heimke. Dr. Power's library was given to the university on condition that it be housed in the building where pharmacy and pharmaceutical chemistry are taught. Consequently the Power library will be added to the pharmacy library on the third floor of the chemistry building.

THE late Edwin Swift Balch, explorer, of Philadelphia, has left $2,000,000 which, upon the death of his widow, is to be used for a museum to be founded in Philadelphia. The museum will house the books and works of art collected by Mr. Balch.

A SCHOLARSHIP of $16,000, subscribed by members of the American Medical Association, has been presented to the Johns Hopkins University in honor of Dr. W. S. Thayer, professor emeritus in the medical school.

A GIFT of $156,000 from Mrs. Grace Rainey Rogers, of New York, to the National Association of Audubon Societies was announced on May 26.

THE Carnegie Foundation has appropriated $90,000 to be used in research work on otosclerosis, according to an announcement made at a meeting of the American Otological Society in the New York Academy of Medicine on May 21. It was also announced that $5,000 had been sent to Dr. K. Wittmaack, of Germany, to continue his experiments with monkeys on ear diseases.

THE council of Manchester University have accepted an offer made by an anonymous donor to endow postgraduate scholarships for research in the biology of plants and animals. The endowment is of the value of about £5,000, and it is proposed to establish two scholarships.

THROUGH the efforts of Professor H. T. Cox, head of the department of physics at Furman University, the Sigma Epsilon chapter of the Sigma Pi Sigma National Physics Fraternity was established on May 16. Dr. J. M. Douglas, head of the department of physics at Davidson College, N. C., installed the chapter. The chapter has nine charter members.

DR. CONSTANTIN DUMBRAVA, a Rumanian explorer now living in New York City, has announced plans for an expedition to Greenland for a study of the relation of glacial conditions within the Arctic circle to storms of the navigable north Atlantic, and to set up a weather bureau on the eastern coast of Greenland to supply shipping with radio warnings. The expedition will be under the patronage of the French Geographical Society and the Belgian Royal Geographical Society, but will be called the Rumanian Greenland Expedition in honor of Dr. Dumbrava's native land. He planned to sail from New York on May 28 and, after lectures before the continental societies backing his expedition, will sail for the North from Copenhagen about July 16 aboard the Danish government ship *Gustav Holm*, which was designed especially for the polar seas.

THE Indian correspondent of the London *Times* states that a geographical expedition is expected to leave Srinagar, Kashmir, in the middle of May for the Chang Chenmo district, and will proceed along the border of Tibet into Chinese Turkestan. It is under the leadership of Mr. E. Tinkler, who will be accompanied by Dr. H. de Terra, geologist, and Mr. W. Bossherd. One of the objects of the expedition is to study the lakes on the Tibetan border. The expedition will proceed from Srinagar to Leh, about 250 miles to the east, and thence to the Chang Chenmo district, and to Pangong Lake, Aksai Chin Lake and Lighten Lake, crossing the passes of the Kuenlun Mountains from east to west in order to reach Kashgar, Chinese Turkestan, by December. The winter will be spent in the Takla Makan desert. The expedition expects to return across Kuenlun in the summer of 1928.

E. S. GOSNEY, a Pasadena philanthropist, is financing and directing a study of the workings of the California eugenic sterilization law. More than 5,000 operations have been performed in the state institutions, under this law, during 18 years, and it is the intention to analyze the effects from all points of view and make the facts public. The investigation has been in progress since the beginning of 1926, and seven papers have already been prepared for publication. The technical side of the undertaking is in the hands of Paul Popenoe, and the work is supervised by an advisory committee consisting of Dr. J. H. McBride, Dr. George Dock, Henry M. Robinson, Otis H. Castle and Paul Popenoe, of Pasadena; Chancellor David Starr Jordan and Professor L. M. Terman, of Stanford University, and Professor S. J. Holmes, of the University of California. The Los Angeles Obstetrical Society has taken up, at Mr. Gosney's instigation, a parallel study of the operations for sterilization performed in private practice.

A FEDERAL forestry reserve of 500,000 acres in northern Wisconsin is proposed in a bill offered by Senator J. S. Carroll, of Glidden. The last legislature authorized a federal forestry reserve of 100,000 acres. When the inspection of the proposed areas was made by federal representatives a year ago, it was found that there were other lands which may be included within such a reserve. The state would retain concurrent jurisdiction with the United States government over the forestry area. Lands so withdrawn no longer would be subject to local taxation.

UNDER the name of the Prince Albert National Park, 1,377 square miles have been set apart in Northern Saskatchewan in order to preserve in perpetuity a section of the primitive forest and lake country, and to provide the people of the province, as well as those of other parts of the dominion, with a great recreational area.

ACCORDING to the Italian correspondent of the *Journal* of the American Medical Association, the Emperor William institute for anthropology, hereditary transmission in man, and eugenics, which is being erected in Dahlem, near Berlin, by the Kaiser-Wilhelm-Gesellschaft, is rapidly nearing completion. Professor Eugen Fischer, anatomist, of Freiburg, will be the director of the institute. He will also be the head of the department of anthropology. The department of hereditary transmission in man will be in charge of Professor Muckermann, a former Jesuit father. The head of the department of eugenics has not yet been announced. It is hoped that the new institute can be dedicated in September, in connection with the meeting of the International Congress on Heredity, which is to be held in Berlin.

THE University of Oregon Medical School is the recent recipient of a portable electrocardiograph which is the gift of Mrs. Charles F. Beebe in memory of the late General Charles Beebe.

ACCORDING to the *Journal* of the American Medical Association Dr. K. Miyajima has announced that the Rockefeller Foundation will donate funds for the establishment of a new chair of public hygiene in the Keio Medical College in Japan.

PRESIDENT COOLIDGE, by a recent order, has set aside a tract of about 2,350 acres in Jasper County, South Carolina, as a preserve and breeding ground for native birds. The area embraces certain abandoned rice lands belonging to the United States and abutting on the Savannah River, near Savannah, Ga., and is to be known as the Savannah River Bird Refuge. The new reservation has been placed under the administration of the Biological Survey of the United States Department of Agriculture.

UNIVERSITY AND EDUCATIONAL NOTES

AIDED by the million dollar gifts of Edward Stephen Harkness, of New York, and Samuel Mather, of Cleveland, the drive for $6,000,000 for the Western Reserve Medical Center has been completed. A total of $6,534,355 was contributed by 5,176 persons to erect a new Lakeside Hospital, a new Rainbow Hospital and a nurses' dormitory. Besides this, two special gifts totaling $1,500,000 were made for special units not included in the original plans.

THE new mines laboratory of the college of mines of the University of Washington was dedicated on May 25.

PROFESSOR HENRY S. GRAVES has resigned as provost of Yale University, effective July 1. Dr. Graves is giving up his office in order to devote his full time to his duties as dean of the Yale school of forestry and as Sterling professor of forestry.

DR. ERNST A. POHLE, of the University of Michigan, has been appointed professor of physiological chemistry at the University of Wisconsin.

DR. D. B. YOUNG, head of the department of biology at the University of Arizona, has been appointed professor of zoology at the University of Maine; Dr. F. H. Steinmetz has been appointed professor of botany and entomology in the university.

DR. PAUL S. SEARS, associate professor of botany at the University of Nebraska, has been appointed head of the department of botany at the University of Oklahoma.

DR. EMIL WITSCHI, of the University of Basel, has been appointed to a professorship in zoology at the State University of Iowa. He will have charge of the graduate and undergraduate work in experimental embryology. Dr. O. M. Helff, associate in zoology at the university, has been promoted to an assistant professorship, and will have charge of the undergraduate work in general and comparative physiology.

DR. J. M. D. OLMSTED, associate professor of physiology at the University of Toronto, was recently appointed professor of physiology at the University of California, not associate professor, as was previously announced. Dr. Olmsted will be on leave the second half year when he will visit the physiological laboratories of Europe.

DR. HARVEY ALFRED ZINSZER, acting professor of physics at the Mississippi State College for Women,

has recently been appointed professor of mathematics at Hanover College, Indiana.

DR. ROBERT B. BRODE, National Research Fellow at Princeton University, has been appointed assistant professor in the department of physics at the University of California.

DR. CHARLES S. GWYNNE, formerly instructor in the department of geology at Cornell University, has been appointed assistant professor of geology at Iowa State College.

DISCUSSION AND CORRESPONDENCE

THE WHALE SHARK, RHINEODON TYPUS, AT THE GALAPAGOS ISLANDS—A NEW FAUNAL RECORD

WILLIAM BEEBE in the log of the *Arcturus*[1] has put on record the finding of a huge shark on the north side of Narborough Island in the Galapagos group on June 9, 1925. It was seen by six members of the staff of the expedition and I have talked with Dr. W. K. Gregory and Mr. John Tee-Van, both of whom saw the shark at close range, and from them have gotten first-hand accounts of its appearance.

Compared with any other sharks seen on the expedition it was enormous, measuring from thirty to forty feet in length. It had a broad blunt head with large and heavy fore parts, but tapered rapidly to a very narrow hinder region and thin tail. It came nearly to the surface of the water in a quartering position under the stern of the *Arcturus*. At first there seemed to be a school of fish some distance below the surface with their sides shining through the rippling water, as they swam in a flock turning from side to side. But as this supposed school approached nearer the surface this illusion disappeared and the "school" took the form of this gigantic shark with its back and sides covered with whitish spots. Unfortunately, the huge fish did not come nearer the surface than two or three feet, and equally unfortunately it quickly sank and disappeared from the sight of the excited watchers.

This huge fish could only have been one of the two great sharks found on the west coast of South America—the basking or bone shark, *Cetorhinus maximus*; or the whale shark, *Rhineodon typus*. That the former fish is found not merely in the southern hemisphere but in the waters along the western shores of South America is shown in a paper which I published some years ago.[2] My chief authority for the occurrence of *Cetorhinus* on the coasts of Ecuador and Peru was Charles H. Stevenson,[3] who quotes a Captain Baker that he was formerly engaged in fishing for bone sharks in these localities for the sake of the oil from their livers. However, Dr. Robert Cushman Murphy very kindly informs me that Captain Benjamin D. Cleveland, master of the brig *Daisy*, told him in 1912 that he had formerly fished for bone sharks for liver oil off the west coast of South America, and indeed not far from the Galapagos.

Clearly the bone shark is found in those waters, and it might be thought that the huge shark at Narborough was *Cetorhinus*, but for two things—*Cetorhinus* is black or at least dark and has a pointed, bullet-shaped head and nose, while *Rhineodon* had a blunt fairly truncate snout and has the body covered with large spots arranged in rows both vertically and horizontally. Undoubtedly the huge Narborough fish was *Rhineodon*.

Furthermore, this occurrence of the whale shark in the Galapagos ties up with other faunal records of its occurrence on the west coast of South America. Günther[4] records that W. Nation in 1878 examined a specimen at Callao, Peru, and sent to the British Museum part of its jaws. In this same little article Günther quotes a letter from Signor G. Chierchia, commander of the *Vettor Pisani*, describing the capture near Taboga Island, in Panama Bay, of a whale shark about twenty-nine feet long.

I sought for years for Chierchia's account of his voyage but vainly, until about a year ago when I found his book in the U. S. National Museum.[5]

Careful translation of Chierchia's Italian text brings forward little data not contained in the account printed in *Nature*. In fact, the two accounts are practically identical. Chierchia sent to Günther among other desiderata a photograph of his specimen, but this was never published, and inquiries of the department of ichthyology of the British Museum (Natural History) bring only the information that in the intervening forty-two years it has disappeared.

However, the discovery of *Rhineodon* at the Galapagos gives us a new faunal record for this great shark, and leads to the belief that it may be found all the way from Callao to Panama.

E. W. GUDGER

AMERICAN MUSEUM
OF NATURAL HISTORY

[1] Beebe, William, "The Arcturus Adventure." New York, 1926, p. 414.

[2] Gudger, E. W., "On the Occurrence in the Southern Hemisphere of the Basking or Bone Shark, *Cetorhinus maximus*." SCIENCE, 1915, Vol. 42, pp. 653–656.

[3] Stevenson, Charles H., "Aquatic Products in the Arts and Industries." Report U. S. Fish Commissioner for 1902, 1904, Vol. 28, pp. 227–228.

[4] Günther, A. C. L., "The Voyage of the *Vettor Pisani*." *Nature*, 1884, Vol. 30, p. 365.

[5] Chierchia, G., Collezioni per Studi di Scienze Naturali fatte nel Viaggi intorno al Mondo della R. Corvetta *Vettor Pisani*. . . . Anni 1882–83–84–85. Roma, 1885, pp. 66–68.—Pesca di un enorme squale (Rhineodon).

THE NEED OF STUDIES OF THE MINERAL NUTRIENT CONTENTS OF FOODS AND FEEDS

THE subcommittee on animal nutrition of the National Research Council wishes to call to the attention of research workers in nutrition the need for further extensive information—which should be readily obtainable—on the mineral nutrients of foods and feeds.

The fundamental importance of the mineral elements in nutrition being universally understood, as also many details of their more obvious functions, much progress remains yet to be made especially in the understanding of their complex interactions, their relations to the vitamins, and their metabolism in tuberculosis, anemia, pellagra, rachitis, caries and the various types of rheumatic disorder.

While animal experimentation in this field must deal primarily with pure compounds the study of dietetic relations calls for a much broader and more detailed knowledge than we now possess of the quantitative presence of mineral nutrients and of the causes of variations in the contents of mineral nutrients, in human foods and animal feeds.

It is well known that the mineral nutrient constituents of the leaves and stems of plants vary widely in response to conditions of growth, such as relating to soil and climate; and even the seeds and fruits of plants vary significantly in these regards, though less prominently than do leaves and stems.

In the light of these facts we believe that the mineral nutrients of each agricultural crop, each food and each feed should be studied in extensive series of samples selected to represent significant environmental conditions or methods of preparation; and it is especially to be desired that such analyses should cover not only the organic nutrients, and those inorganic elements ordinarily considered as nutrients —namely, sodium, potassium, calcium, magnesium, sulphur, phosphorus, chlorine, iodine and iron, but also those others the functions or effects of which are much less perfectly known—namely, manganese, fluorine, bromine, silicon, boron, aluminium, copper, arsenic and zinc.

It is the hope of the committee that studies of soil fertility and of plant and animal nutrition may be so expanded as to yield information of the kinds specified and that new researches may be undertaken for the specific purpose of bringing forth the knowledge desired.

PAUL E. HOWE,
Chairman, Subcommittee on Animal Nutrition, National Research Council.

ENGLISH VS. METRIC SYSTEM

I REGRET that Professor Gortner (SCIENCE, February 11, 1927, p. 163) should take exception to the use of the term a "quarter of wheat" in the paper by Mr. Williams and myself but I am quite unrepentant.

While I heartily agree with him as to the merits of the metric system and the unscientific basis of the English system of weights and measures, the fact remains that the latter system is still in general use in this country for all except scientific purposes. The *scientific data* in papers published in scientific journals should be, and usually are, given in metric units, and our paper is no exception to this. The sentence which Professor Gortner quotes deals with information which is not scientific, but agricultural; since in the art of agriculture the unscientific British system of weights and measures is still in use, it is necessary to give such information in language which is readily intelligible to those familiar with Briitsh agricultural conditions. It is primarily for such that this information was intended, and had the usual yield of wheat from this land been stated in say metric quintals per hectare, or even in hundredweights per acre, the British reader would have had to calculate back into quarters or bushels per acre, since he is accustomed to think of the yielding capacity of agricultural land in terms of the units of yield used by the farmer. It is true that this puts the foreign reader at a disadvantage, but he can readily convert into metric units if he consults a suitable authority.

Here I must parry the charge of writing in an unscientific manner, which is implied in Professor Gortner's remarks, by suggesting that in seeking for the sense in which we used the word "quarter," he himself has not proceeded as scientifically as might have been expected from a scientist of his distinction, "to whom English is the native language, and who has been brought up to use the English system of weights and measures." If he had consulted Webster's New International Dictionary, a standard work of reference produced under American editorship, he would have found the definition: "Eight bushels, the fourth of a ton, used especially in measuring grain." Consultation of the "Encyclopaedia Britannica," 10th Edition, Vol. 22, p. 713 would similarly have yielded the definition: "as a measure of capacity for grain it measures eight bushels." The quarter, and the bushel, are of course primarily measures of volume, and the weight of a measured bushel varies with the kind of grain, and with different samples of the same grain; Webster's parenthesis "the fourth of a ton" is not strictly accurate. For conversion to weights of wheat an arbitrary average factor must be used,

but by reference to Vol. I of the same work, under the heading "acreage and yields of British crops" in the articles on Agriculture, p. 398, is found the definition: "per imperial quarter, that is, 480 lbs. of wheat"; the imperial bushel is the same as that in use in the United States, 60 lb. of wheat.

Finally the International Institute of Agriculture of Rome, of which one function is that of coordinating and distributing agricultural information, has published a useful book: "Recueil de Coefficients et d'Equivalences" (4th Edition, 1922) in which are given the metric equivalents of the weights and measures of all countries. Here, on pp. 30 and 31 we find "quarter = 8 bushels = 2.90942 hl" and "1 Quarter froment = 480 liures = 2.17724 q."

Thus, despite the inconvenience caused by the failure of this country, as well as the United States, to adopt the metric system of weights and measures, there is no special difficulty in defining a quarter, and in converting it to metric units, if the source of reference is chosen with due regard to the context in which the term is used.

H. J. PAGE

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THE LOGARITHMS OF NAPIER

READERS who have not consulted the original writings of John Napier will be misled by an article by Professor G. A. Miller in the Proceedings of the National Academy of Sciences, September, 1926, p. 537, denying the accuracy of the equation,

$$\text{Nap. log } x = 10^7 \log_e \frac{10^7}{x},$$

to explain the relation existing between the logarithms invented by Napier and the natural logarithms. We read:

> The inaccuracy of this equation, according to later historical studies relating to logarithms, results directly from the striking and well known theorem that the only pair of algebraic numbers which satisfies the equation $y = e^x$ is $x = 0$, $y = 1$. The tables which Napier computed imply that the rational integral numbers listed therein have rational integral logarithms, according to his use of this term. It is, therefore, obvious that no general exact rational relation can possibly exist between these so-called logarithms and those of base e, since Napier did not consider any operation leading to transcendental numbers. The fact that the given equation is approximately true is of secondary interest.

The tables of Napier represent in general only approximate values, as do all logarithmic tables. But the fundamental theory, as found both in his "Descriptio" and in the body of his "Constructio," leads to a "general exact rational relation" between his logarithms and those of base e, and involves transcendental numbers. Napier's conception of logarithms is kinematic and based on continuity. Napier uses expressions, such as, points "travel," "distances traversed in equal times," "ducenda sit linea fluxu . . . puncti," which can not be successfully interpreted without admitting continuity. We quote from the "Constructio" (§§ 25, 26) the specification for his "geometrically moving point" and his definition of "logarithm":

> A geometrically moving point approaching a fixed one has its velocities proportionate to its distances from the fixed one.
>
> The logarithm of a given sine is that number which has increased arithmetically with the same velocity throughout as that with which radius began to decrease geometrically, and in the same time as radius has decreased to the given sine.

Logarithms are here defined by the *velocities* of two points, and it is easy by aid of the calculus to derive, rigorously, the above equation, as is done in my "History of Mathematics" (2d ed., p. 150). Napier uses such phrases as "incommensurable number," "*bc*, the logarithm of the sine *dS*" (*bc* and *dS* being line segments), "the logarithm which *bc* represents," logarithms "may be included between near limits." These and Napier's mode of deriving his theorem on limits, and his fundamental theorem, "logarithms of proportional numbers or quantities are equally differing," make it very evident that, in the presentation of his theory, Napier looked upon logarithms as exact values deduced from the above kinematic definition of a logarithm.

FLORIAN CAJORI

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AN UNAUTHORIZED REPRINT

I should feel grateful, if you will permit me through your columns to draw attention to the issue in the United States without my permission of a reprint of my "Grammar of Science." That work without revision is hopelessly out of date, and it is not only an injury to the author but an insult, if it leads any purchaser to suppose that the treatment of the subject in 1911 is an adequate criticism of the state of physical science in 1927, and represents the present views of the writer.

Morality in such matters appears to differ very widely on the two sides of the Atlantic. I can only sympathize with a well-known British author who on seeing a multinational publisher enter a club-room remarked to me: "Now Barabas was a publisher."

KARL PEARSON

SCIENTIFIC BOOKS

The Embryology of the Pig. By BRADLEY M. PATTEN. 323 pp., with 372 figures and a colored plate. P. Blakiston's Sons & Co., Phila., Pa. Price, $3.50.

BRADLEY PATTEN has again scored a marked success in this little book. The "Embryology of the Pig" will be ranked among the best of our text-books. With his former "Embryology of the Chick," Dr. Patten's accounts of these chapters of embryology make the story of development live for the student, while leading him, in a most interesting manner, to examine the facts for himself in the laboratory.

The reviewer would compare these up-to-date little texts of vertebrate embryology, for their combination of stimulating interest and vision of the meaning of processes, together with their practical treatment, to Balfour's "Elements" in the 80's, which is high praise.

It has been possible for Patten to make a great advance in two respects. First, the influence of a great growth of the literature of the subject is felt all through the new work; and secondly, Dr. Patten has devoted considerable study to the rich collections of the Carnegie Embryological Laboratory in Baltimore, where is found a great variety of specimens, models and illustrations of stages of the pig, paralleling one of the most extensive set of human material in the world. This has assured breadth of view and makes the statements of the author authoritative. It warrants his personal opinions where controversy has confused topics.

Glancing at the special characteristics of the book, we find certain interesting comparisons and supplementary features to those of the "Embryology of the Chick." The later text is a valuable extension of the earlier, as well as a supplement. Thus, much more space is given here to the history of germ-cells, maturation, the sexual cycle and fertilization. This is in accord with the special availability of such material for the mammal, as well as because of the large amount of published work on these stages of mammals. The chapter on cleavage, formation of the germ-layers and the development of the blastocyst is another most useful supplement to what is given for the chick. Such a definite and complete account of these stages of the pig has been long needed for our text-books. The incorporation of results from the Carnegie collection has done much for this chapter; and for the next on relations of embryo in uterus and membranes; as well as in the review of stages of the development of the body-form and primary systems. Here we are given, for the first time, ages of the chief stages. Something of the kind may have been given before, here and there, but the full series of pictures and timed data for the pig now furnished is consecutive and definite and gives a most convenient basis for comparisons with other mammals and man.

Chapter VII presents a rather full examination of early pig embryos, which are comparable to the four-day stage of the chick, well studied in the former text-book, and already familiar to the student. It is easy to turn from these stages of the pig to the study of human embryos, since models and well-illustrated articles abound for the human from this period onward.

The first seven chapters, or 137 pages, have carried the development well beyond the topics taken up for the chick; relatively early stages. Here is a thoroughly analyzed fundamental stage of a mammal, reminding one of Minot's 9 mm to 12 mm pigs, and furnishing an excellent basis for the comparisons and correlations which the author makes with the chick.

The rest of the book, 160 pages, is devoted to chapters which cover most of the features of later development.

The author, however, decides to select and emphasize certain topics, even at the expense of others which will be slighted. He feels that some subjects can be taken up in preference to others because of ease of technique, or special interest, while others would prove too difficult to warrant the time required. So although he covers the most important aspects of most systems of organs, some which may be regarded of equal value are not considered at all. This is announced as a definite plan, and the introduction should be read not only for the explanation, but also for other opinions and suggestions.

Some teachers will object to the omission of the lymphatic system, the later history of the musculature, skull and jaw development, sense-organ stages, and other special topics. The absence of such sections does indeed remove the book from the category of the ordinary systematic, all-around symmetrical and complete text-books. It must be remembered, however, that this little book is not ordinary, but a departure. We have already quite a series of the more complete, comparative and systematic type to which the teacher may refer for what is omitted.

The chapter on the nervous system groups the stages of development interestingly around a functional discussion and takes up items basal to later study of neuro anatomy. It might be well to add a few more paragraphs on the developmental changes in relations through which the basal ganglia of the third ventricle and the lateral ventricles are brought together, with the resultant adult shape of the lateral ventricle, and the defining of the Insula. A couple of figures would help here, showing these relations and the choroid plexus of the brain opened and viewed from above in pig embryos of about 40 mm.

The digestive and respiratory systems and the

glands derived from the pharyngeal walls are passed over rather lightly in Chapter IX. There is also absence of discussion of the later history of the mesenteries. Chapter X, however, is on the contrary a rather full and complete treatment of changes in the development of the kidneys and reproductive system and includes an excellent series of figures.

The circulatory system is well discussed and looks very modern with many of Heuser's and Butler's splendid figures, as well as new ones by the author, especially on the heart. The reviewer regrets the omission of the lymphatic system, since the chief stages in vessels and glands can be readily demonstrated in pig embryos and because American workers have contributed valuable papers and illustrations in this field, and important problems still lie before us here. The same might be said for the vessels of brain, face and appendages.

Chapter XII is devoted to the development of bones and of the skeleton. It is presented as a type of detailed study of one system, through histogenetic and macroscopic steps, studied by a variety of methods which give a good idea of how such work is done, as well as the results. The teeth are similarly studied in considerable detail, and many excellent new pictures are introduced in both of these chapters. Another good series is a set of pictures of the development of the face and palate in the pig.

The volume is concluded with an excellent bibliography, where the most important papers, especially modern studies, which deal with the stages considered in each chapter, are listed. References are also given to subjects slighted in the text.

Finally, the reviewer would conclude that the author of this little book has achieved a noteworthy success. It is a stimulating and exceptional text, and the publishers have certainly done their part thoroughly well. They have permitted a generous number of new illustrations, reproduced in excellent manner. These pictures not only parallel the text, but add much information. The careful artistic work of the author and his assistant is of course at the bottom of the success of the illustrations.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A RAPID METHOD FOR MECHANICAL ANALYSIS OF SOILS

As our knowledge and understanding of soils becomes greater, clearer and more comprehensive, the more we are coming to the conclusion that practically all the physical as well as the physical-chemical reactivities or relationships of soils reside almost entirely in the colloidal portion of the soil. Such properties or phenomena, for instance, as absorption of chemical elements, base exchange, retainability of plant food constituents, hygroscopic water, adsorption-absorption of water, water-holding capacity, capillary movement of water, evaporation of water, unfree water, wilting coefficient of plants, cohesive and adhesive properties of soils, shrinkage of soils, easiness of tillage operations, etc., are controlled mainly, if not entirely, by the colloidal portion contained in the soil. A study of soils, therefore, is really becoming to be a study of the colloidal portion of the soil.

This rather radically changed view of soils has been mainly brought about in the last few years by the discovery that the colloidal content of soils is infinitely greater than we used to think. The old idea, which was handed down mainly from the work of Schloessing, maintained that the amount of colloids in soils rarely exceeded 1.5 per cent. The newer methods of measuring the amount of colloids in soils, however, such as the water vapor adsorption, heat of wetting, base exchange and hydrometer method, show that the colloidal content of average soils is very high; in the sandy loams it may be as high as 20 per cent., loams 30 per cent., clay loams 50 per cent. and clay 75 per cent.

The old notion also maintained that whatever colloidal matter there was in the soils, it existed as a coating around the soil grains. It has recently been shown by the writer, however, that such is not entirely the case. The colloids exist in the soils both as a coating and as an independent component; which one of these forms predominates depends upon the amount of colloids present and upon the type of soil. In many soils, however, the largest amount of colloids exist as an independent component.

A great stride has recently been made in the study of colloids by the discovery of a method for determining the colloidal content of soils very rapidly as well as accurately. By the water-vapor adsorption, base exchange and heat of wetting methods, especially the first two, it would take more than a week to make a determination of the colloidal content of a soil. By the new method, which is the hydrometer method, it takes only about fifteen minutes to make a determination. The hydrometer method is able to accomplish this, by a rather remarkable factor or relationship that has been discovered to exist between the percentage of colloids as indicated by the heat of wetting method and the percentage of material that stays in suspension in a liter of water at the end of fifteen minutes, based upon the amount of sample taken. This relationship may appear to be empirical and incredible, but it has a fundamental relationship behind it, and the results it gives on the

determination of the colloidal content of soil seem to be correct. The hydrometer method can also be used to measure the rate of settling of soil particles, from which a distribution curve could be worked out.

If it is true that the colloidal portion of the soil controls almost entirely its physical as well as its physical-chemical reactivities, as enumerated above, the question arises whether, for practical purposes at least, the determination of the colloidal content of soils would be sufficient in the mechanical analysis of soils. In other words, would merely the knowledge of the colloidal content coupled with field or sight identification be sufficient in giving us a fairly true picture of a soil, at least for practical purposes?

A comprehensive and deep consideration of the subject would seem to reveal the fact that at least in most of the phenomena or properties mentioned above a knowledge of the colloidal content of the soil is all that is necessary. For instance, if it is true that the colloidal content of soils is infinitely higher than we used to think; if it is true that all the heat of wetting and unfree water as found by the writer is controlled almost entirely by the colloids; if it is true that the water adsorption of soils is about 95 per cent. due to colloids and only about 5 per cent. due to non-colloids, as found by the U. S. Bureau of Soils; if it is true that practically all the base exchange is in the colloids as found by Parker and Pate, then certainly all that is essential to know, for these particular properties, is the colloidal content. The rest of the material acts more or less as an inactive skeleton. What is true of these properties or phenomena is undoubtedly true also of many of the others of the foregoing list, such, for instance, as the retainability of plant food, wilting coefficient of plants, shrinkage of soils, facility to water percolation, etc. There are some properties, of course, where the non-colloidal material exerts considerable influence as, for instance, in the water-holding capacity. In this case the surface and interstices of the non-colloidal material influence the total water-holding capacity. On the whole, however, there are very few if any properties of the soil which are not controlled either entirely or predominantly by the colloids.

The determination of the colloidal content does not, of course, give us the relative amounts of all the separates in the soil, but the important question to consider is, is it necessary from a practical standpoint to know the relative amounts of all the separates, since, as stated above in most cases, they merely function as inactive skeletons.

But even when we do get the relative amounts of the separates of a soil by the standard mechanical analysis, do we have the true facts? That is, do our present mechanical methods give us the true facts? If the results yielded by the methods of water-vapor adsorption, heat of wetting, base exchange and hydrometer method all show that the colloidal content of soils is infinitely greater than we used to think, then the results of the mechanical analysis method are not correct. For instance, what the mechanical analyses call clay and silt may almost all be colloids, by the new conceptions.

There seem to be three serious objections to the present methods of mechanical analyses. The first is that they are terrifically laborious and time-consuming; second, because they are so laborious and time-consuming they are employed very little to-day, and third, the results they give do not agree with our present views of soils.

In view of the above facts about the mechanical analysis of soils, in view of the fact that the colloids seem to control all the properties of soils, and in view of the fact that the amount of these colloids can now be determined in only about fifteen minutes by the hydrometer method, then it would seem that greater advance could be made by using the hydrometer method to make a mechanical analysis of soils. Because of its simplicity and rapidity everybody could use it and all the soils could be studied by it, which is impossible to do by the mechanical analysis.

By experience we know approximately when we see it that a soil is clay, loam, silt loam, sandy loam, sand, etc. If we take a sandy loam, for instance, and determine its colloidal content, and we find that it is 20 per cent., then we know that the other 80 per cent. is mostly sand, with probably some silt. The field or sight identification, together with the colloidal content, would seem to give a fairly good description of soil for all general practical and essential purposes. At any rate the colloidal content is the most important and essential single determination from the mechanical standpoint.

Like the other separates of the soil, the soil colloids are not all of the same size. While a determination of the amounts of the various sizes would be desirable, yet generally speaking it is not so important from a practical standpoint. What is probably far more important and essential is the knowledge of the activity of the colloids. Different colloids give different amounts of heat of wetting, which is partly an indication that they are in a different activated condition. The difference in activity may be partly accounted for by assuming that colloids from various soils may not all represent the same degree of decomposition or maturity, and consequently they do not all have the same state of hydration, porous, rough and felt-like surfaces, even though in size of particles they may not differ so greatly. This dif-

ference in activity makes the colloids react differently. The hydrometer method does not show this difference in activity, but the heat of wetting does. Part of this activity or condition of the colloids, however, is apparent to the eye or touch. For instance, some colloids are not so sticky or plastic as others.

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SPECIAL ARTICLES

OCEANOGRAPHIC RECONNAISSANCE OF THE NORTHERN SECTOR OF THE LABRADOR CURRENT

THE coastal waters off northern Labrador have long been neglected as a field for scientific study, being neither far enough away to warrant an elaborate arctic expedition nor yet near enough to be reached easily. With the modern development of dynamic oceanography it is now possible through subsurface measurements of temperature and salinity not only to secure an accurate picture of the extent of a gradient current, but also to understand how and why it flows. This gives an increased value to well-planned subsurface observation, although in most parts of the sea the stations must be many, and close together, for the best results. Along the Labrador Coast, however, the contrasts in temperature and salinity are so great that fewer stations will suffice to indicate the dominant, dynamic tendencies, so that this region offers a most promising field for a short cruise.

The existence of a powerful south-flowing arctic current, coming out of Davis Strait and following the coast line southward for 1,600 miles to the so-called "Tail" of the Grand Banks, has long been common knowledge. The fact that this arctic flow transports many bergs from Baffin Bay south to the shipping lanes aroused sufficient interest in England (1913, after the *Titanic* disaster) for the sending out of the *Scotia* expedition. Since 1914 the U. S. Coast Guard cutters on the Ice Patrol Service have spent much of their time studying the physical properties of the waters of the region, so that we now have a nearly complete picture of the circulation in the vicinity of the Grand Banks and as far north as the Strait of Belle isle. But north of this point subsurface observations off shore in the Labrador current proper, have been confined to two stations made by the *Scotia* at about lat. 54° 30′ N.

During the summer of 1926 an oceanographic reconnaissance of the current off the Labrador coast was carried out by eight Harvard students, under the leadership of C. Iselin. In a seventy-seven foot schooner, named the *Chance*, the expedition sailed as far north as Cape Chidley, the northeastern extremity of the peninsula. Forty-five stations were occupied for serial observations, at many of which plankton hauls were also made.

It is impossible here to give more than a brief survey of the more important results of the expedition, which are still being worked up at the Museum of Comparative Zoology. But two profiles of the Labrador current show the south-moving icy water considerably narrower than had previously been supposed. The current was confined to the water over the continental shelf and therefore extended off shore only eighty-five miles off Nachvak Bay (lat. 59° N.) and one hundred and twenty-five miles off Sandwich Bay (lat. 54° N.). At the outer edge of the current there was a very abrupt change from water as cold as −1.5° C. to water of 4° C. At the same time the salinity increased from less than 33.5 to about 34.5 per thousand. This region of transition was so sudden that the isotherms and isohalines are nearly vertical when plotted to the usual scale on cross-section paper. The *Chance* data, compared with the *Scotia* stations, shows that outside the edge of the continental shelf the water of this sector is remarkably homogeneous, and as far as is yet known has little dynamic cause for movement. The inshore water, though very cold, is much less saline and therefore lighter than the offshore water, a contrast great enough to cause a gradient current of about twelve miles a day to the southward along the whole length of Labrador. That this current is comparatively constant in character and volume all the way from Davis Strait to Newfoundland is proven by the available information.

Although the study of this northern sector of the Labrador current is as yet in its infancy, the following preliminary statement seems warranted. Land drainage supplies about as much fresh water to the coastal edge of the current as is lost along its outer edge through mixture with the warmer and more saline north Atlantic water. The great vertical stability of the water layers is a factor in keeping the temperature practically constant throughout the length of the current, because in summer a thin surface film of water of low salinity averaging about 3° C. in temperature prevents the penetration of solar warming by convection to the deeper water, which continues southward nearly at its winter value (−1.5° C). This same surface film is prevented from warming to any great extent during the summer, first by the field ice in the spring, and later by the melting of the bergs which it carries south. In this way a considerable volume of water with a temperature of less than 0° C. and a salinity of about 33 per thou-

sand is transported all the way south to the Grand Banks.

Besides the oceanographic work, a collection of plants was secured from the Torngat region of northern Labrador. This comparatively high range of mountains rises from four to six thousand feet directly out of the sea and is indented by several little known and very beautiful fiords. In the course of exploring these opportunity was had to learn something of the northern limits of the Atlantic salmon, and the southern limits of the Greenland char. Lastly, the expedition was able to contribute to the intensive studies of the cod now being carried out by the U. S. Bureau of Fisheries, by bringing back a series from northern Labrador.

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EXCHANGEABLE HYDROGEN AND SOIL REACTION

BASE exchange investigations have received much attention recently, and the procedures employed have been described in detail. Ammonium chloride has come to be the most commonly used salt for displacement of the alkalies and alkaline earths, while barium chloride is preferred for the determination of exchangeable hydrogen; the latter salt has recently been recommended for the displacement of all bases.

So far as the writer is aware, ammonium acetate has not been mentioned as a base exchange salt, but it seems to have some important advantages, which will be discussed.

It is a "neutral" salt, the ionization constants of ammonia and acetic acid being nearly the same, about 1.8×10^{-5} at 25°; both acid and base are very weak, hence the salt is a good buffer around the neutral point. The use of a neutral buffer solution for leaching the exchangeable bases from the soil appears to be the logical procedure. Without doubt exchangeable hydrogen obtained in the extracts is closely correlated with pH of the solution in contact with the soil, hence the amount of ammonia absorbed and the total absorbent capacity of the soil will depend upon the same factor. For this reason it would seem advisable to use a solution at some definite reaction in all cases. If such solution is neutral, the solvent effect upon soil minerals should be less than if it was acid. Ammonium acetate is completely volatile on the steam bath and is easily gotten rid of by simple evaporation without danger of loss, and without the use of nitric acid as required for the destruction of ammonium chloride. A normal solution of ammonium acetate at pH 7.0 is a good solvent for all the bases which may be expected to be concerned in soil work, including iron and aluminum, considerable quantities of which remain in the hydrosol condition in such a solution at ordinary temperatures. It will not dissolve these hydrated oxides from the soil, however, as ammonium citrate does, hence if they are found there is a strong presumption that they have entered the solution by true interchange; the buffer properties of the salt make it seem unlikely that the amounts of free acetic acid resulting from exchanged hydrogen would raise the H-ion concentration sufficiently to dissolve an appreciable amount of these elements, but which might very easily happen with ammonium chloride. A normal solution of ammonium acetate at pH 7 does not attack calcium carbonate to as great an extent as ammonium chloride does, although the solvent effect is not negligible. More organic matter is dissolved by the acetate than by the chloride, although the writer has never encountered any soil giving more than a straw-colored extract, nor had any difficulty from this source. Ammonium acetate is readily soluble in alcohol, permitting the use of this solvent for the removal of the excess salt from the leached soil, for the subsequent determination of the absorbed ammonia. Alcohol is better than water for the purpose, as it runs through faster, and there is no tendency for the ammonium absorption complex to break up in alcohol, as usually happens when washed with water.

Unfortunately, ammonium acetate is not obtainable in pure neutral crystals; the commercial salt is rather indefinite in composition, but always contains excess acid. A normal solution of the neutral salt is therefore best prepared by mixing equal volumes of carefully prepared twice normal acetic acid and ammonia, checking the reaction by means of the quinhydrone electrode and adding sufficient acid or ammonia to bring to exact neutrality and water to compensate for the contraction in volume occurring on mixing these strong solutions.

One hundred gram portions of soil crushed to pass 2 mm are percolated with 750 cc of the solution; according to the writer's experience, this volume is sufficient to remove the exchangeable bases from the silt loam soils so far investigated. The percolation is conducted in an apparatus so arranged that the solution is protected from the atmosphere, a point of importance if exchanged hydrogen is to be determined. This determination presents some difficulty, in consequence of the buffer properties of the salt. By a procedure of electrometric titration, however, excellent results have been obtained. The entire percolate is poured into an 800 cc Pyrex beaker, 0.5 g. quinhydrone added, and a comparison electrode

vessel made from a thin test tube with fused-on siphon and stopcock, and containing some of the original acetate solution with a little quinhydrone supported in the beaker. Electrodes cut from the same piece of platinum foil are immersed in the solutions, and connected through a very sensitive galvanometer. The solution in the beaker is vigorously stirred by motor, while fifth normal ammonia is run in at a rather rapid rate until the galvanometer shows no deflection. By the adoption of a standardized procedure, it has been found possible to obtain consistent results on duplicate percolations made at different times. It is necessary to renew the solution in the comparison electrode vessel for each determination and to work rapidly, as the quinhydrone is quickly oxidized and the electrodes become polarized. The titrated solution is evaporated, organic matter gotten rid of by a careful ignition in the beaker and the subsequent separations made by standard methods. The alkalies are determined in the same solution after the magnesium, which is precipitated as arsenate, and the filtrate evaporated and ignited; the excess arsenate is entirely volatile with ammonium chloride. Needless to say, in this procedure it is necessary to use minimum amounts of pure ammonium salts only as reagents. The ignition in glass has not been found to result in any considerable contamination; the blank for potassium has always been found to be low, and while that for sodium is important and for calcium appreciable, the principal source of these impurities has been traced to the ammonia solution used for the preparation of the acetate.

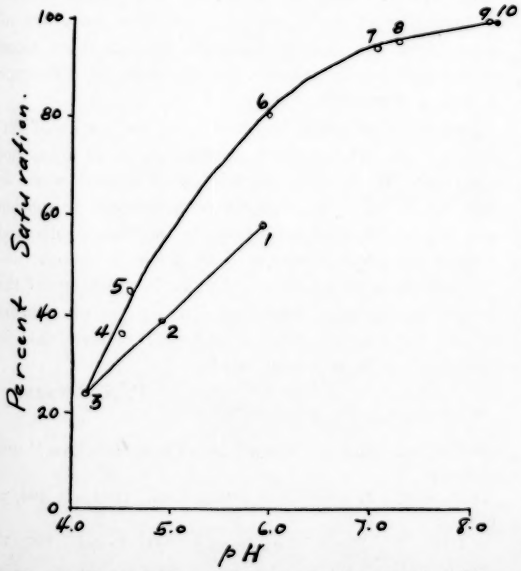

FIG. 1. The relation of degree of saturation to pH. The numbers refer to the various horizons.

The best criterion for general accuracy in these procedures is the excellent balance between the sum of milligram-equivalents of cations exchanged and ammonia absorbed by the leached soil. Surface soils sometimes show an excess of ammonia absorbed, possibly due to absorption of ammonium acetate as a whole by organic matter. Soils containing much carbonate show excess of base dissolved, which may be corrected for by determinations of carbonate in original soil and leached residue, best dried and finely ground for this purpose. Drying the leached soil prior to determination of absorbed ammonia is not permissible, as ammonia has been found to be lost.

In an examination of samples from a Clermont silt loam profile, a detailed description of which will appear elsewhere, an excellent correlation between percentage of total base absorbent capacity satisfied by neutral salt-forming bases and soil reaction has been discovered. This soil represents an extreme example of weathering *in situ* of a very old (Illinoian glaciation) calcareous till, the highly eluviated surface and subsurface horizons being acid and practically all carbonates leached out to the depth of eight or nine feet. The relation is shown graphically in the figure, degree of saturation being plotted against pH determined on 1:1 suspensions of dried soil and water, after 3 days standing for equilibrium to become established. The points are numbered according to order in sampling, 1 being surface soil and 10 the parent material, 108–120 inches, with over 25 per cent. carbonate. The figure shows that the first two horizons are less acid and more saturated than the third, and that beginning with the fourth horizon acidity decreases and degree of saturation increases as the parent material is approached. From the first to the third horizon the points are on a straight line, but points corresponding to lower horizons are all near a smooth curve with slope different from that of the line. The difference in slopes may indicate that there is a difference between base absorbents at the surface and below, perhaps due to the presence of organic matter.

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TUMORS IN KALE

DURING the past two years experiments have been made in an effort to induce tumors by artificial stimulation in kale plants. Three methods have been utilized, involving (1) the subjection of the entire plant to vapors; (2) subjecting localized areas of leaf sur-

face to vapor effects; and (3) stimulation by injections made with hard glass needles.

The first and second methods involving stimulation by means of vapors were productive only of warty intumescences similar to those formed in the greenhouse and outside in certain conditions of light and humidity without stimulation by means of chemical vapors. The vapors of ammonia, alcohol (ethyl) and acetic acid increased to a considerable degree the number of intumescences produced but did not definitely increase their size. This effect was produced without bringing about artificially reduced transpiration. This, as far as ammonia is concerned, is in accord with the work of von Schrenk[1] and with Smith's work[2] with each of the three.

In the third method, needles sealed at one end were filled with the solution to be used by heating and later cooling with the open tip in the solution, so that the liquid was drawn into the needle with the contraction of the enclosed air. The tip was then sealed and broken off later at the time of injection. The tip was inserted into the midrib of the leaf or some other portion of the plant and again warmed at one end with a match to drive the contained liquid into the tissue or they were merely left with the tip inserted and diffusion depended upon to carry the material out into the tissues. Little difference was noted in the results obtained by the two methods of injection.

As a result of these injections extensive proliferation occurred resulting in the formation of small "tumors" of varying size up to two and one half centimeters in length to one and one half centimeters in breadth, not infrequently breaking through the leaf on both the upper and lower sides. Both hyperplasia and hypertrophy occurred with a disappearance (or non-appearance) of the chlorophyl from the tumor tissue. There was not only a proliferation of parenchymatous tissue, but also in many cases the phloem became involved. The nuclear structure showed, as far as investigated, no particular deviations from the normal (no double or giant nuclei).

The following materials were injected into the leaf midrib with definitely positive results in the percentage of cases given.

N	Sodium	chloride	18.2 per cent. of the trials
0.1N	"	"	53.9
.05N	"	"	8.7
.02N	"	"	9.1
.01N	"	"	28.6

20 per cent.	Ethyl alcohol	48.2
1 " "	" "	58.5
10 " "	" "	66.6
0.1N	Calcium chloride	23.5
1 per cent.	Acetone	73.0
1 " "	Glycerine	41.2
1 " "	Cane sugar	54.5
	Paraffine oil	16.6
	Distilled water	25.0
	Extract of kale	53.3

When empty needles were inserted no tumors were formed, although a certain amount of callous tissue was produced which was not comparable to the tumors described above.

The ability of such a variety of materials to induce tumor formation leaves the causative factor in kale, as with plants used in other investigations,[3] very much in doubt. Apparently any wound accompanied by a liquid injection is sufficient stimulus; other conditions being favorable to bring about the proliferation of tissue.

External weather conditions appear to be of considerable importance in this type of tumor formation, as is true in the formation of intumescences.[4] Tumors of large size were produced here only during the spring rainy season when there was abundant rainfall, minimum daily sunlight and humid atmosphere. Only very small tumors or none at all were produced during the dry season, even in cases where an effort was made to reproduce rainy season conditions under glass of varying penetrability to sunlight and under burlap kept moist by a continuous water spray. That conditions of the plant, relative to turgidity of cells and transpiration rate, are of importance can not be doubted, though these alone do not apparently account for the seasonal difference in tumor formation.

The effect of light, believed by Dale[5] to be of importance in intumescence formation, is at least not apparent in these experiments. Further work is planned relative to conditions governing formation and to physiological conditions in the tumor cells, and a more complete report will be made elsewhere.

I wish here to express to Dr. L. B. Becking, of the School of Biology, Stanford University, my sincere thanks for suggestions, interest and material aid in carrying on these experiments.

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[5] Dale, E., Royal Soc. Lond., Phil. Trans., 196, V. 198, p. 221.